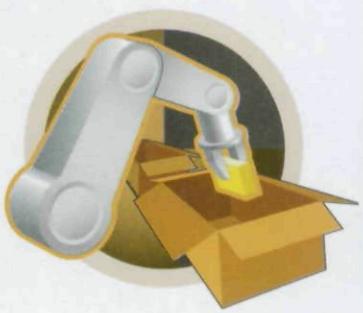
Programmable Logic Controllers

Even in a tight economy, PLCs and PACs are hot commodities, a true testament to their control adaptability, flexibility, and multi-feature capabilities.

Dick Johnson
Control Engineering



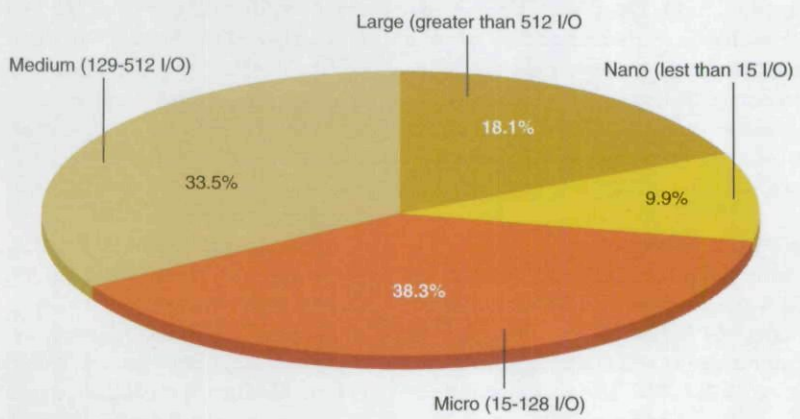
With the venerable programmable logic controller (PLC) marking its 40th anniversary this year, I got to thinking about its timeline. It goes way back in my engineering career—the career before my involvement with *Control Engineering* magazine. So I asked a fellow engineer, whose involvement in the control industry includes more history than mine, what he thought.

"There's evolution and then there's revolution," said Bill Southard, president and CEO of DST Controls, a systems integrator from Benicia, CA. "Mr. [Dick] Morley sparked a revolution in machine building techniques with his introduction of the PLC (actually then called a 'programmable controller' or 'PC') back around the time the earth cooled. This created excitement and benefited the machine builder in three very major ways," he says:

- The first and foremost benefit was the reduction of time it took to design, prototype, and then build a machine. This benefit was derived from the fact that the logic could actually be worked out while the machine and control panel were being built, not after all the relay logic diagrams were completed and checked.
- Secondly, machine builders could easily reprogram the PLC to add new features to both new and existing machines, thus extending the life of the products.
- Lastly, the control panels associated with the machinery could be smaller, making it possible to mount the controls on the machines rather than on an entire wall.

"All of the above resulted in significantly lower costs to the machine builders in both manpower and hardware," Southard says. The programmable automation controller or PAC (essentially a ruggedized PC in a PLC-like form

Programmable controller types in use



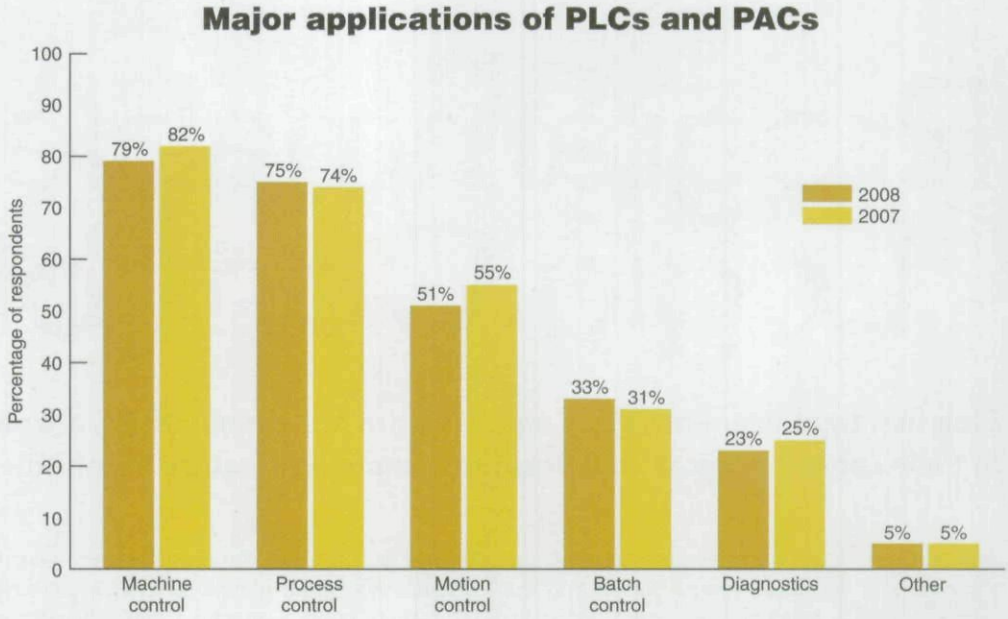
Source: Control Engineering *and Reed Research*

Nearly all respondents (92%) will buy PLCs/PACs in the next 12 months. Shown are devices already installed.

ONLINE

For more on the history of PLCs, see p. 66. That PLC 40th anniversary article also can be found online at www.controleng.com/archives under Sept. 2008

The majority of PLCs/PACs are used for embedded control in machine- or process-control applications.



Source: Control Engineering *and Reed Research*

factor) is "merely an evolutionary product that extends the mighty power of the good old PLC," adds Southard. "Now, it is specifically designed for connectivity and distributed I/O, thus continuing to make design easier. But, alas, so do the new terminal block designs.

"Mostly, I see [PACs] as a public relations move so that the young engineers of today don't have to work on the same hardware their fathers did. Evolution is a slow process that often goes unnoticed without a view of history. Give me a good old revolution any day." (For more history of the PLC, see "How programmable controllers emerged from industry needs" on page 66 of this issue.)

Revolution or not—evolution or not, the 405 respondents who answered the joint *Control Engineering*/Reed Research product research study on PLCs and PACs will be increasing their purchases of these devices over the next 12 months. Even with the tight economy, 23% of respondents expect their purchases to increase. Of those polled, 69% expected purchases to remain the same as last year, and only 8% expect them to decrease.

Putting PLCs to work

Of the control engineers queried in this online survey, 54% use their PLCs/PACs for in-plant requirements, 14% use them for OEM or resale requirements, and 12% use them for both. Choice of PLC/PAC size was also reflected in this survey. Nano devices (fewer than 15 I/O points) accounted for 9.9% of installed PLCs. Micro devices (15-128 I/O points) were installed 38.4% of the time. Medium (129-512 I/O points) and large (more than 512 I/O points) were specified 33.5% and 18.2% of the time, respectively. As expected, these figures nearly mirrored the results of the previous year's survey.

Of these installed devices, the survey found that the majority of them were used as embedded controllers rather than PCs, data loggers, or SCADA apps connected to PCs. As for major applications, PLCs and PACs were used mostly in machine control (79%). Process control (74%), motion control (55%), batch control (33%), and diagnostics (23%) rounded out the survey results. See accompanying graph for these ratings as compared to those of 2007.

When asked how most of their plant's PLCs or PACs networked with other control systems, respondents said the most (29.1%) networked with other PLCs. Standalone devices accounted for 24.4% of the responses. The remaining interface "partners" were distributed control systems (21.4%), personal computers (21%), and other PACs (3%).

Getting them to talk

Communication protocols for PLCs were also the subject of this survey. The top ten list of those currently used (listed most popular first) is: serial (RS-232 and RS-485), 4-20 mA, Ethernet (wired), Allen-Bradley Remote I/O, DeviceNet, Modbus, ControlNet, general wireless, BCD (binary coded decimal), and Profibus.

With the current popularity of the Ethernet protocol in mind, the survey queried control

professionals about their preferences of both type and function of their Ethernet networks. Of those using Ethernet, 70% used it as a supervisory network, 67% used it as controller to controller networking, 54% used it to control I/O, and 41% used it for enterprise connectivity.

Ethernet protocols that respondents currently use or plan to use with their PLCs or PACs ran the gamut of those available. They are (in order of popularity): TCP/IP, EtherNet/IP, Modbus TCP/IP, High Speed Ethernet (HSE), Profinet, UDP, EtherCAT, Sercos II, EtherNet Powerlink, FL-net (OPCN-2). A discussion of these protocols can be found in a previous product research article on industrial Ethernet, which appeared in the May 2008 issue of *Control Engineering*.

Languages used to program PLCs and PACs were also a subject of this survey. A tally of the responses made it clear that control engineers use ladder diagrams almost two-to-one over the second most popular method, function block. Structured text was not a close third, rating less than two-to-one behind function blocks. C programming, sequential function charts, flow charts, proprietary software, and instruction lists were all mentioned, with none getting substantial support.

Giving 'em what they want!

PLCs and PACs are available with a wide array of features that allow them to be adapted to applications. A total of 30 different features were deemed "very important" when selecting a PLC or PAC, as reported by survey respondents. Categories of features included communications issues/adaptability, speed/memory capabilities, form factor availability, etc. In order of frequency of selection, the most commonly preferred feature—number one by nearly a two-to-one margin—was built-in communications support. Rounding out the list of top ten features (in order of preference) are:

- Scan time
- Availability of analog I/O (strain, vibration, etc.)
- PID availability
- Total memory
- Availability of universal programming software for multiple hardware targets/platforms
- More remote I/O subsystems
- Controller I/O networked to PCs
- Motion support
- Integrated I/O modules.

The overall list included 20 more features that were desired by control professionals who completed the survey.

PACs are considered much more adaptable and powerful than their predecessor, the PLCs. But have they gained the acceptance of the automation communication yet? Per this survey, PAC purchases over the next 12 months exactly mirrored those reported for the PLC, indicating true acceptance by the control community. Verbatim responses on the subject of PLC vs. PAC use were mixed, however. Comments ranged from tongue-in-cheek comments to specific advice: "Just call a PLC a PAC, or call a PAC a PLC. There is no real need to use different name." "PLCs are like 'old faithful' and PACs are the new kids and I'm trying to figure exactly what's better about them and why."

As for specific advice, one control engineer commented, "If

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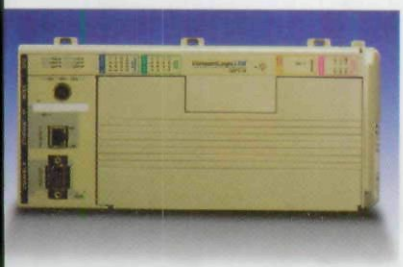

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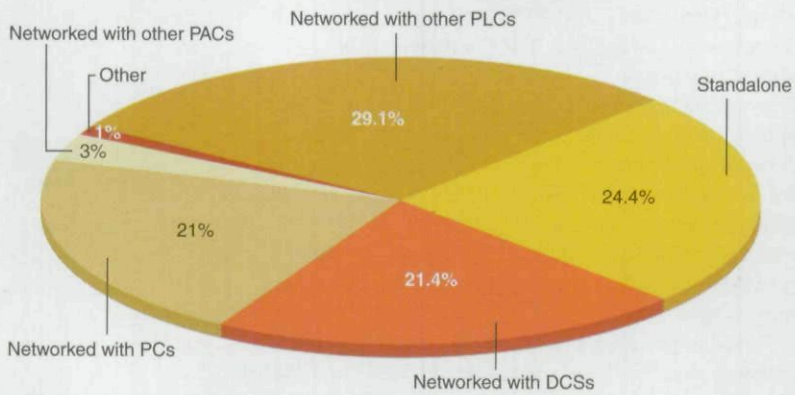
How PLCs/PACs are interfaced with control systems



Source: Control Engineering *and Reed Research*

I am using a lot of servos, then I choose a PAC. Otherwise, if the application is just on and off, [I use] a PLC." Another said, "We would use PACs where the functionality of the PLC is being extended beyond its engineered, off-the-shelf purpose."

"We don't see PACs being used in that many SCADA applications. The PAC approach generally offers superior capability when combining continuous and sequential control. It also shines when data analysis is important, [or] where a database or database interface is important to the project," said yet another respondent.

Clearly, the control engineering community

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is ready to embrace improving technology. Their message to PLC/PAC vendors is simple—bring it on! In the survey, working from a supplied list, respondents named the following vendors as most-purchased-from manufacturers of PLCs and PACs. The list is shown in descending order, along with descriptions of representative products.

Additional vendors and product descriptions, along with links to vendor Websites, can be found with this article online at www.controleng.com/archives for September 2008. For more manufacturers, visit www.controleng.com/buyersguide. For complete Product Research results on programmable logic controllers, click the Resource Center tab at www.controleng.com.21

Advanced features, simple configuration

The Allen-Bradley CompactLogix L23 programmable automation controllers are said to deliver the latest control technology to small machine-level applications through simplified configuration and an advanced set of features. The controllers, which come in three packaged forms, offer customers the benefits inherent in the company's proprietary Logix Control Platform: a common programming environment, common networks, and a common control engine for future control upgrades. Each PAC also features embedded I/O that is preconfigured for ease of use. All of the CompactLogix L23 PACs offer 512KB of memory, supporting up to three tasks and four programs. Embedded EtherNet/IP integrated ports are available for advanced connectivity.

www.rockwellautomation.com

Rockwell Automation

DC output modules with fault protection

AutomationDirect's line of DirectLOGIC option modules includes new fault-protected output modules designed for the DL205 PLCs. The F2-16TDxP 16-channel current output modules, available in sinking and sourcing configurations, feature 16 input points that are automatically assigned as fault status indicators for the corresponding outputs. Equipped with electronic short circuit protection, the modules detect missing external 24 V dc open load, over-temperature, and overcurrent load. The protected output modules also feature user-resettable fault conditions.

www.automationdirect.com

AutomationDirect

Distributed controller with Profinet

The new Simatic ET 200S IM151-8 PN/DP CPU module adds another processor to the ET 200S I/O family of distributed I/O devices. Communicating via Profinet, the new CPU is similar in power and performance to the S7-300 line of controllers. Its built-in Profinet communication interface includes three ports for linear bus topologies and programming device functions. Communications can also be expanded easily with a Profibus DP master module. As a Profinet I/O controller, the module also supports the real-time properties RT and IRT

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Schneider Electric

(isochronous real time) and can control up to 128 I/O devices. A fail safe version is also available with a built-in proprietary ProfiSafe safety network. The CPU can be expanded modularly in a central rack configuration or distributed via ProfiSafe on Ethernet for combined standard and safety rated applications. *www.sea.siemens.com*

Siemens Energy & Automation, Inc.

Batteryless unit added to line uses same software

The Modicon M340 PLC has been added to the Modicon Quantum and Premium controller lines, with all supported by the proprietary application development software, Unity. The Modicon M340 PLC is said to provide numerous cost and performance advantages over comparably priced PLCs by requiring no battery; offering a compact size (4-in high by 3.7-in deep); using high density 64 point I/O cards that are only 1.25-in. wide; and offering pre-terminated cables with flying leads or Telefast connections to reduce wiring time. Additionally, these PLCs use CANopen networks to reduce field wiring and lower installation costs, as well as USB cables rather than proprietary cables. They also feature enhanced processing power with 4 MB of memory (upgradeable to 16 MB) and an execution speed of 70K instructions/ms. They exceed IEC requirements for shock and vibration. *www.telemecanique.com*

Schneider Electric

Open standards, portable control engine

The PACSystems intelligence platform is built to open standards with a portable control engine, a single development tool, and a universal development environment. It is said to represent a revolutionary change in the control industry, one that "enables control convergence rather than mere integration of disparate parts and pieces." Using the PACSystems intelligence platform, users can take advantage of a powerful engineering environment for multiple operations. The PACSystems family addresses major engineering and business issues such as high productivity and communications openness, and helps users boost the overall performance of their automation

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systems, reduce engineering costs, and significantly decrease concerns regarding short- and long-term migration and platform longevity. *www.gefanuc.com*

GE Fanuc

New automation platform on the way

This fall, Mitsubishi Electric Automation Inc. promises to "advance the state of the art in automation" with the Q Series automation platform. Q Series is a multidisciplinary automation platform that combines all the elements of common automation systems into one compact, integrated, and high-performance system. The platform combines sequence, motion, process, and PC-based control on a single, compact, rack-based system. By taking this approach, the system reportedly will integrate sequence control, complex motion profiles, and continuous process control while also being able to run any third-party PC application for control, data handling or any other application.

www.meau.com

Mitsubishi Electric Automation Inc

Compact PLC with window included

The Visual KV Series PLC is a high-speed, compact unit with what is said to be the industry's first built-in access window. The product line includes an ac power supply model and an optional operator interface panel. The new ac version 40 I/O KV is said to be two-thirds the size of conventional PLCs. Its slim design not only saves mounting space but allows the entire system, including the distribution panel and the control box, to be downsized for ac types that use screw-type terminal blocks. The Visual KV Series is said to have the fastest processing speed among products of this class. Minimum scan time is 140 µs and the minimum instruction execution time is 0.7 µs. *www.keyence.com*

Keyence America

Small size, increased performance

Three new compact FieldPoint controllers deliver increased performance, higher processor speed, and significantly improved (10 times better) Ethernet throughput, compared to their predecessors. The NI cPF-2220, cFP-2210,

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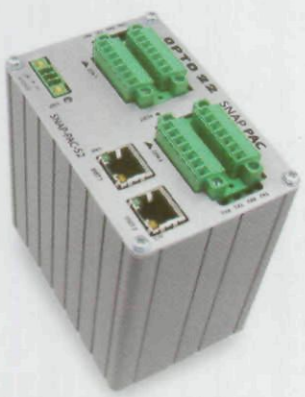

Opto 22

and cFP 2200 controllers include a 400 MHz PowerPC processor and Wind River VxWorks real-time operating system for greater processing power and faster data analysis. The cFP-2200 features up to 128 MB of SDRAM and onboard storage, and the cFP-2210 delivers up to 256 MB of SDRAM and up to 128 MB of onboard storage. The cFP-2220 has dual Ethernet ports for connectivity to enterprise and dedicated I/O networks, as well as three RS232 ports and one RS485 port for serial devices. For logging and transferring data on external memory, the controller includes an additional USB port and a removable CompactFlash slot. The cFP-2220 also has twice the amount of onboard storage and SDRAM, up to 256 MB, for storing more data on the controller itself. Control engineers can create standalone embedded systems with these new controllers by using LabView Real-Time. *www.ni.com*

National Instruments

Modules make the controller

The ELC Logic Controller is a reduced-size PLC with "an abundant module selection." The product line offers four controller styles, 1-, 4-, 8-, 16- and 32-bit instructions, remote communication, easy connectivity to drives and I/O, and built-in displays. This PLC is DIN rail mountable, allowing users to add as many modules as desired using snap-on/slide-into-place installation. Users can choose from 4, 8 or 16 I/O expansion modules that are CE compliant. *www.omega.com*

Omega Engineering Inc.

Drive control simplified

The NextMove e100 programmable controller provides 16 axis of interpolated motion and includes an addressable range to manage up to 240 drives, I/O devices, gateways, and other Ethernet Powerlink devices. The drive axes provide simple point-to-point motion, homing sequences, jog control, and torque demand functions. The device integrates management of a real-time Ethernet network, which greatly simplifies system design and installation. The e100 uses a processor to deal with all communications requirements, leaving the main digital signal processor to handle time-critical motion tasks. The communications core even deals with message redirection where messages were not intended for this device (i.e., information from the USB port can be redirected to Ethernet devices). A field programmable gate array core provides flexibility of design allowing firmware updates. A user-selectable RS-485/RS-232 serial port is available; developers use the company's proprietary programming language, Mint, to create a simple interface to devices such as PLCs, text displays, and printers. *www.baldor.com*

Baldor Electric

PLC connects the dots

SNAP-PAC-S2 is a standalone, multi-serial port, dual Ethernet interface programmable automation controller. The controller has four serial ports, each of which is fully configurable for either RS-232 or RS-485 serial communication for connecting to machines, devices, instrumentation, I/O subsystems, and other equipment with serial interfaces such as weigh scales, vibration monitors, RFID and barcode readers, display terminals, and printers. An RS-232 point-to-point protocol (PPP) modem connection for communication over leased lines, radios, and cellular networks is also supported. The SNAP-PAC-S2 also features two 10/100 Mbps Ethernet interfaces for host and I/O communication over Ethernet networks. These two independent interfaces can be used to create dual Ethernet networks for segmenting I/O and host traffic, or to design redundant Ethernet links for critical applications. *www.opto22.com*

Opto 22

Compact, scalable PLC power

The compact CP1L series of micro programmable controllers delivers a scalable solution for automating small machines with as few as 14 I/O points, with flexibility to expand to 180 I/O points. It is said to offer faster processing speeds than other micro controllers, and built-in positioning capabilities. The CP1L series shares the same architecture as the CP1H, CJ1, and CS1 controller models, so programs are compatible for memory allocations and instructions. The CP1L supports IEC 61131-3 programming via CX-One Software that features time-saving libraries of controls and function blocks that simplify program development, as well as online editing of program logic. A group of motion control functions unique to CP1L establishes automatic communication with variable frequency drives and servos without ladder programming. Simulation software included in CX-One allows pre-testing of programs without any hardware and shortens commissioning time. The CP1L uses a standard USB port for programming and monitoring, and offers up to two optional plug-in RS-232C and RS-422A/485 serial communication ports. *www.omron247.com*

Omron Electronics LLC

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